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Ou

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(54) **CRANE**

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B66D 1/38 (2006.01)
B66C 23/36 (2006.01)

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CPC ***B66D 1/38*** (2013.01); ***B66C 23/36*** (2013.01)

(58) **Field of Classification Search**
CPC .. B66D 1/36; B66D 1/365; B66D 1/38; B66C 23/36
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

524,619 A * 8/1894 Sturm B66C 9/14 212/198
3,095,183 A * 6/1963 Bus, Sr. B66D 1/36 254/272

(Continued)

FOREIGN PATENT DOCUMENTS

EP 2 281 771 A1 2/2011
JP H04-014287 U 2/1992

(Continued)

OTHER PUBLICATIONS

International Search Report issued in Application No. PCT/JP2018/004497, dated Mar. 27, 2018.

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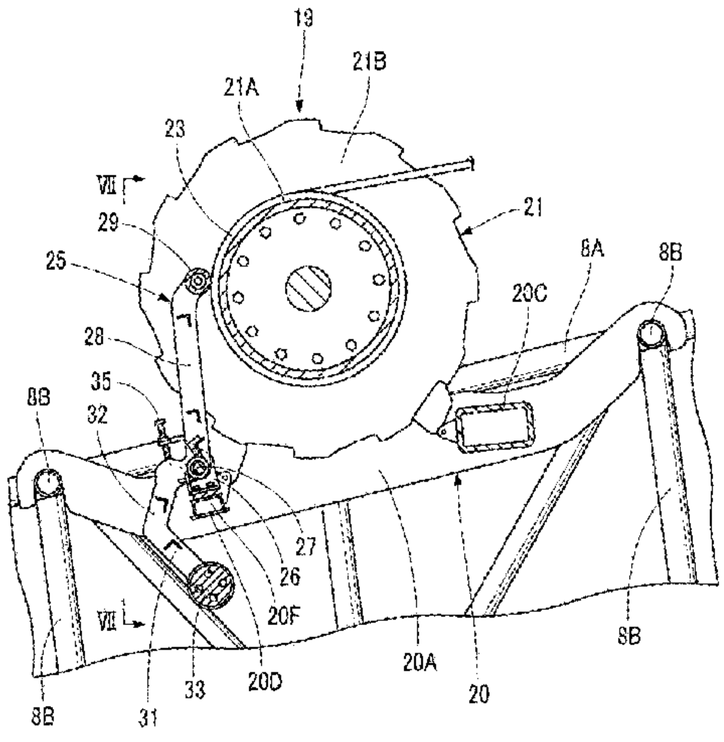
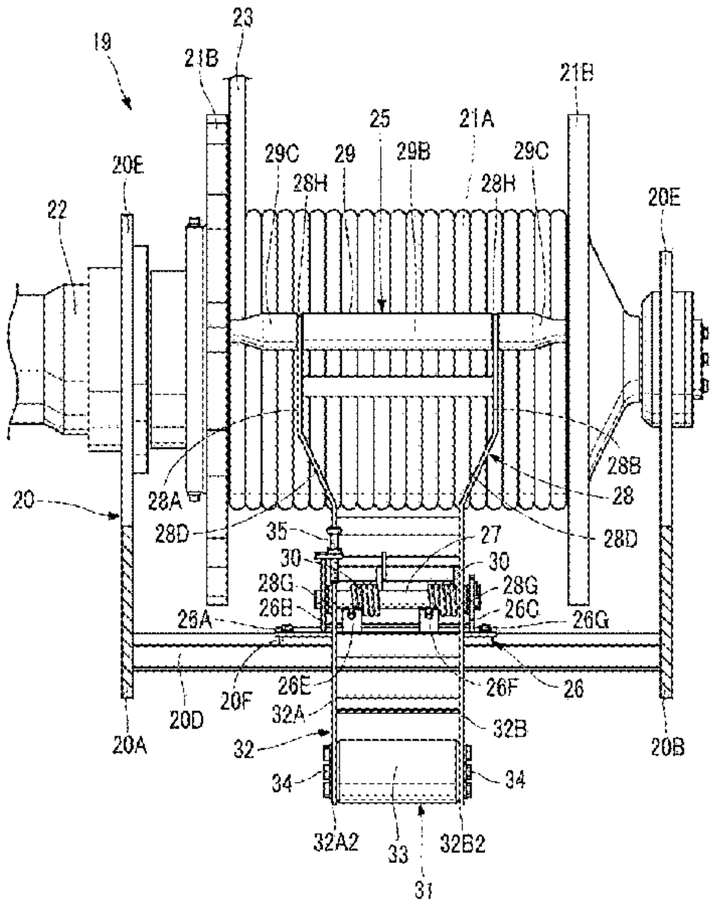
(57) **ABSTRACT**

A crane includes a crane body, a boom, a hoisting winch, and a rope holding device pressing a rope wound around a drum of the hoisting winch against the drum. The rope holding device includes an oscillating arm whose proximal end is attached to a base of the hoisting winch using a support shaft and distal end oscillates in a direction close to or away from the drum, and a rope presser which is attached to a distal end of the oscillating arm, extends in an axial direction of the drum between a pair of flanges, and abuts against the rope wound around the drum. A weight member, which biases a distal end side of the oscillating arm in a direction close to the drum by the gravity with the support shaft as a fulcrum, is provided at the proximal end of the oscillating arm.

20 Claims, 9 Drawing Sheets





(56) **References Cited**

U.S. PATENT DOCUMENTS

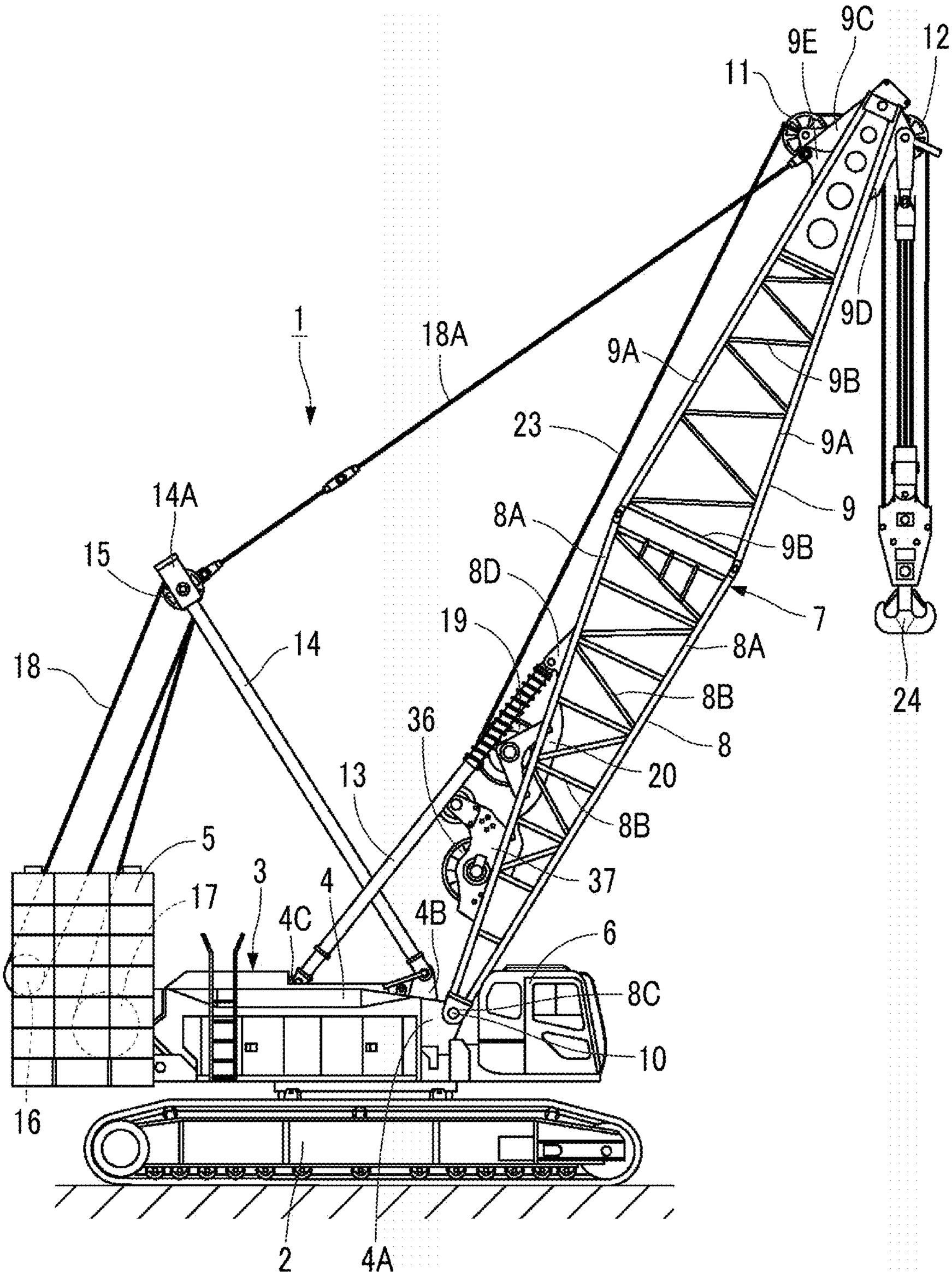
4,005,852	A *	2/1977	Schmitmeyer	B66D 1/54 254/266
5,002,238	A *	3/1991	Inhofer	B66D 1/36 242/156.1
9,248,999	B2 *	2/2016	Xydias	B66D 1/36
9,908,756	B2 *	3/2018	Heravi	B66D 1/46
10,336,590	B2 *	7/2019	Hall	B66D 1/30
2008/0099421	A1 *	5/2008	Pech	B66C 23/76 212/196
2008/0116161	A1 *	5/2008	Kurotsu	B66C 23/82 212/262
2008/0203045	A1 *	8/2008	Pech	B66C 23/76 212/270
2011/0031202	A1 *	2/2011	Pech	B66C 23/76 212/178
2014/0091268	A1 *	4/2014	Heravi	B66D 1/505 254/274
2015/0076266	A1 *	3/2015	Crawford	B66D 1/38 242/156.1
2015/0284223	A1 *	10/2015	Hall	B66D 1/22 254/333
2017/0107084	A1 *	4/2017	Yu Date	B66C 13/18

FOREIGN PATENT DOCUMENTS

JP	2003-238082	A	8/2003
JP	2010-215336	A	9/2010
JP	2011-037634	A	2/2011

* cited by examiner

FIG. 1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19
8A
14
18
8B
36
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FIG. 2

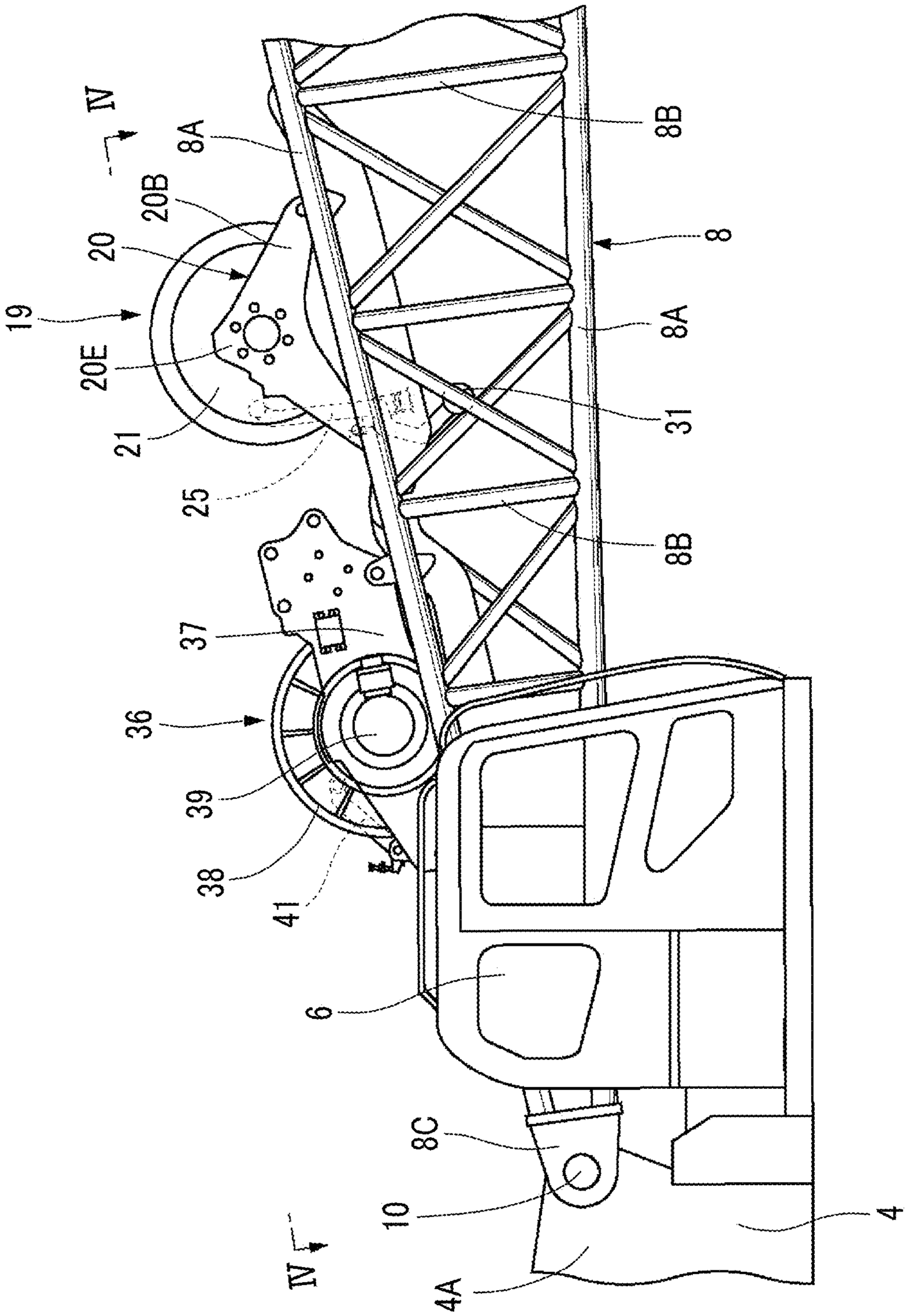


FIG. 3

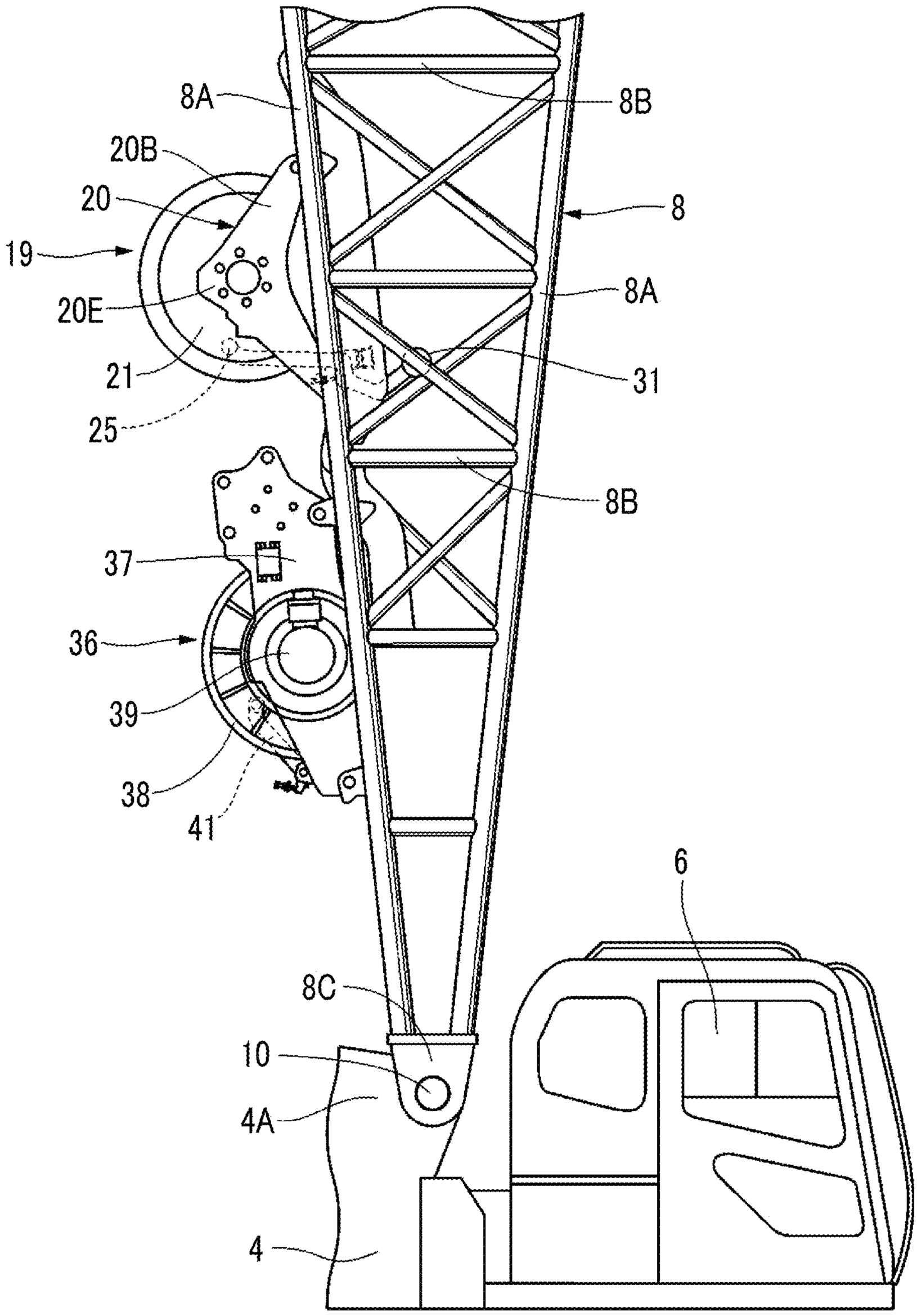
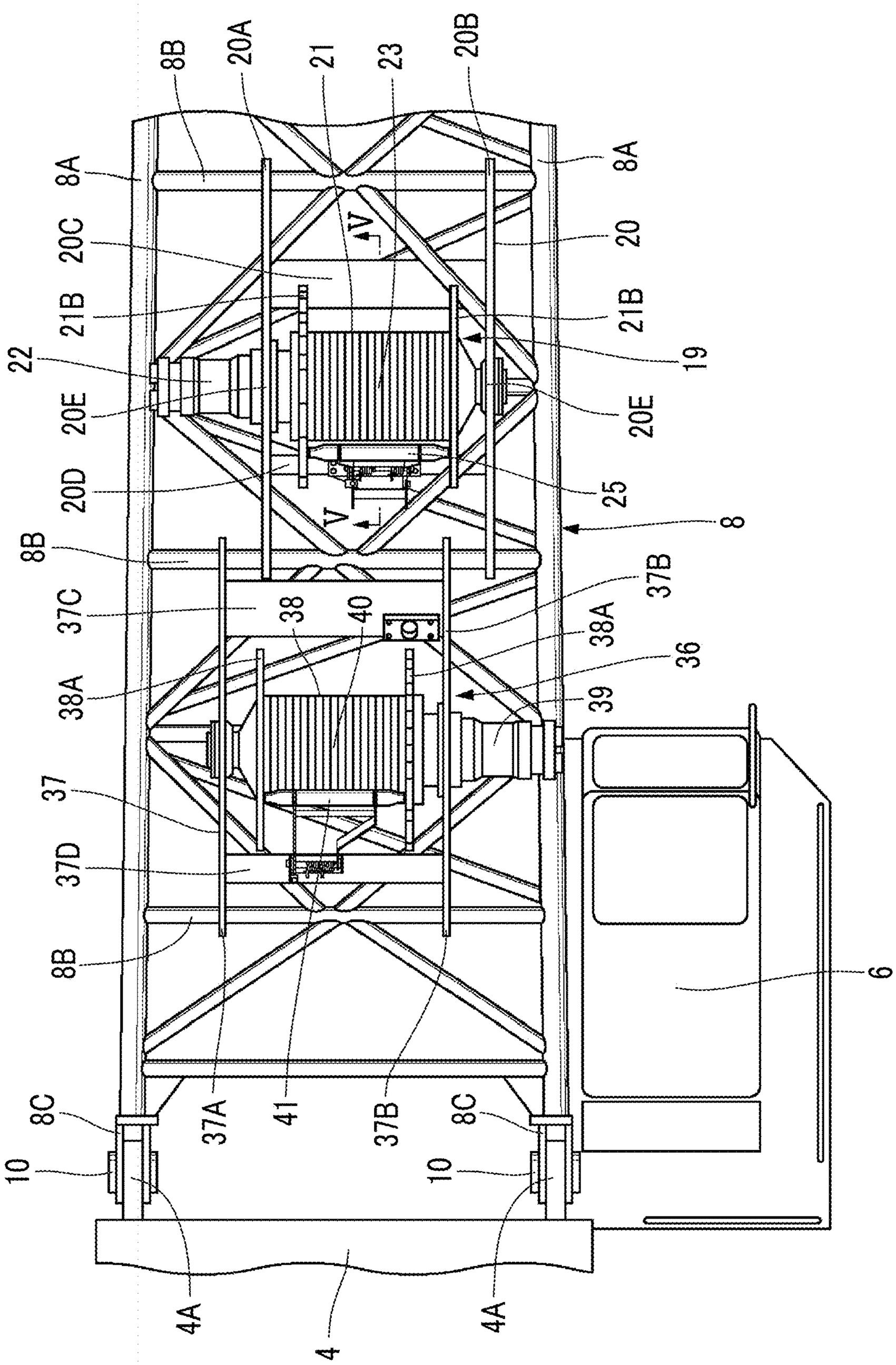


FIG. 4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37B
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FIG. 5

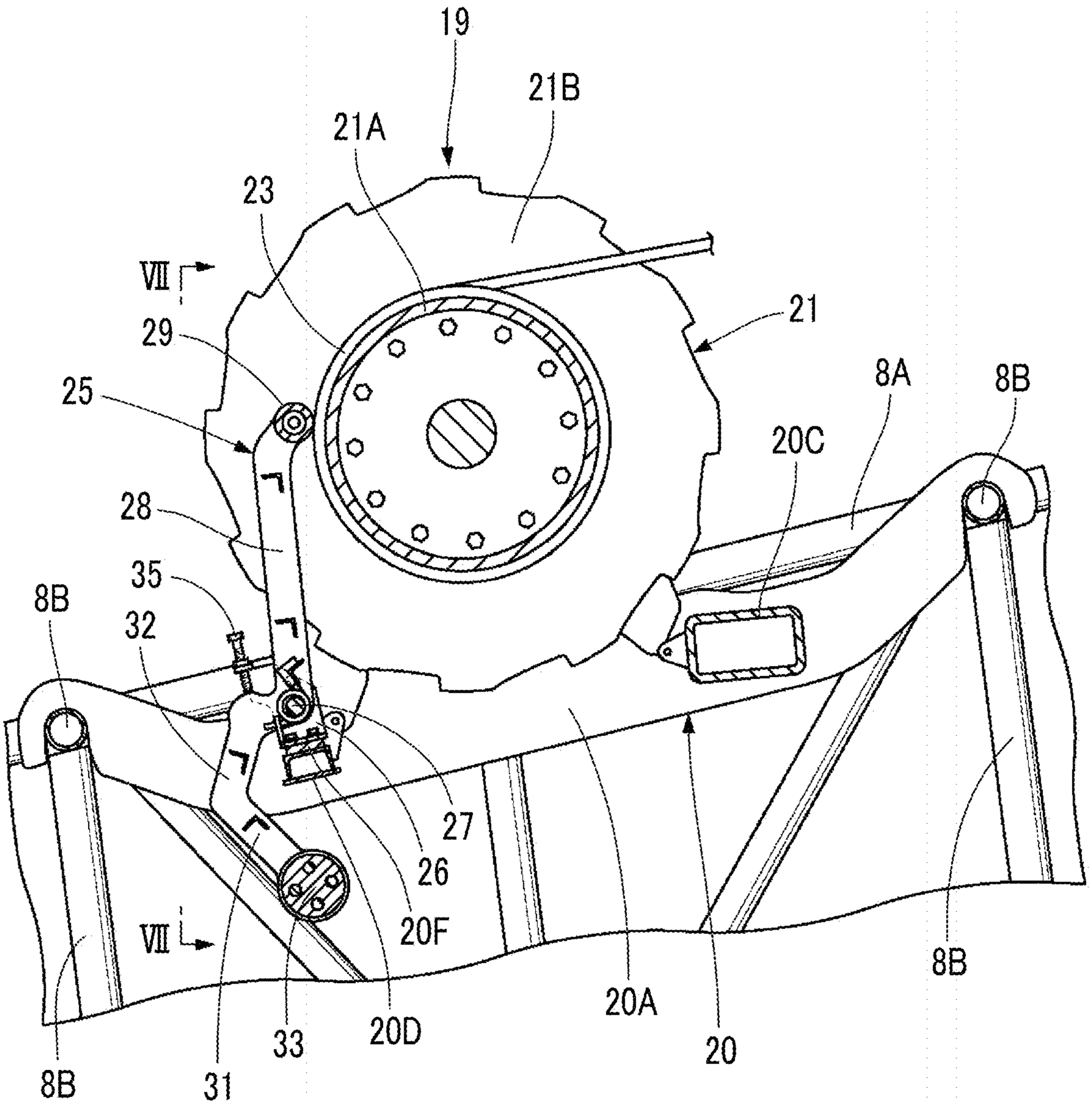
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FIG. 6

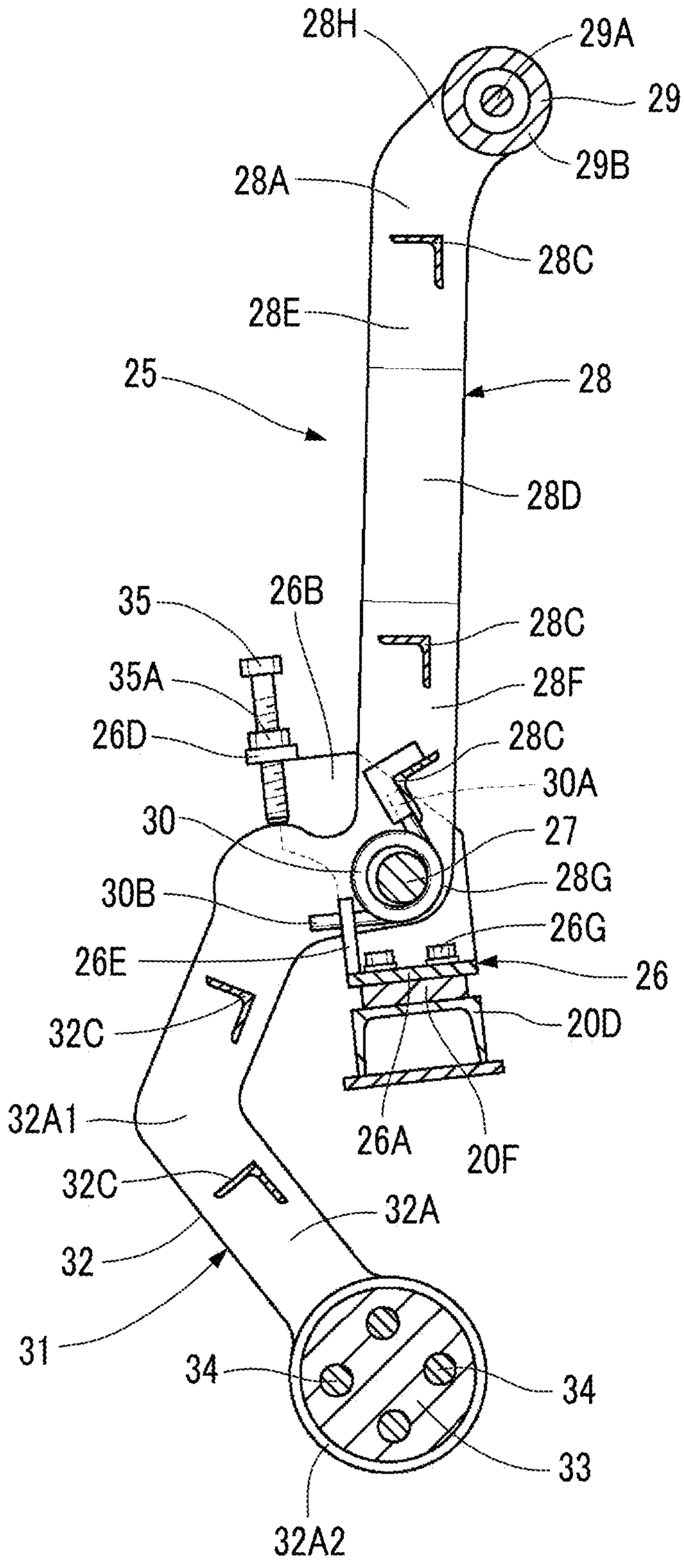
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FIG. 7

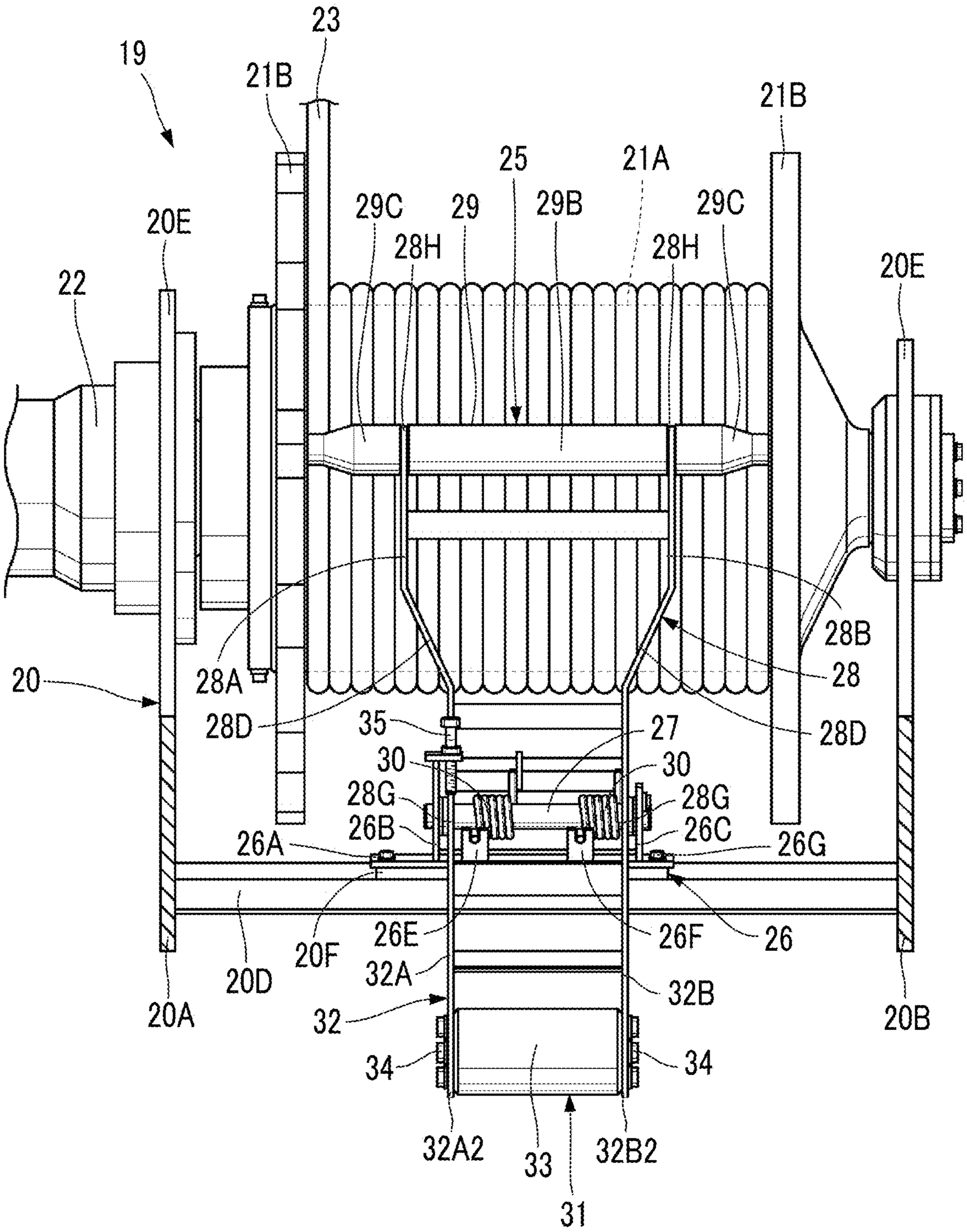
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FIG. 8

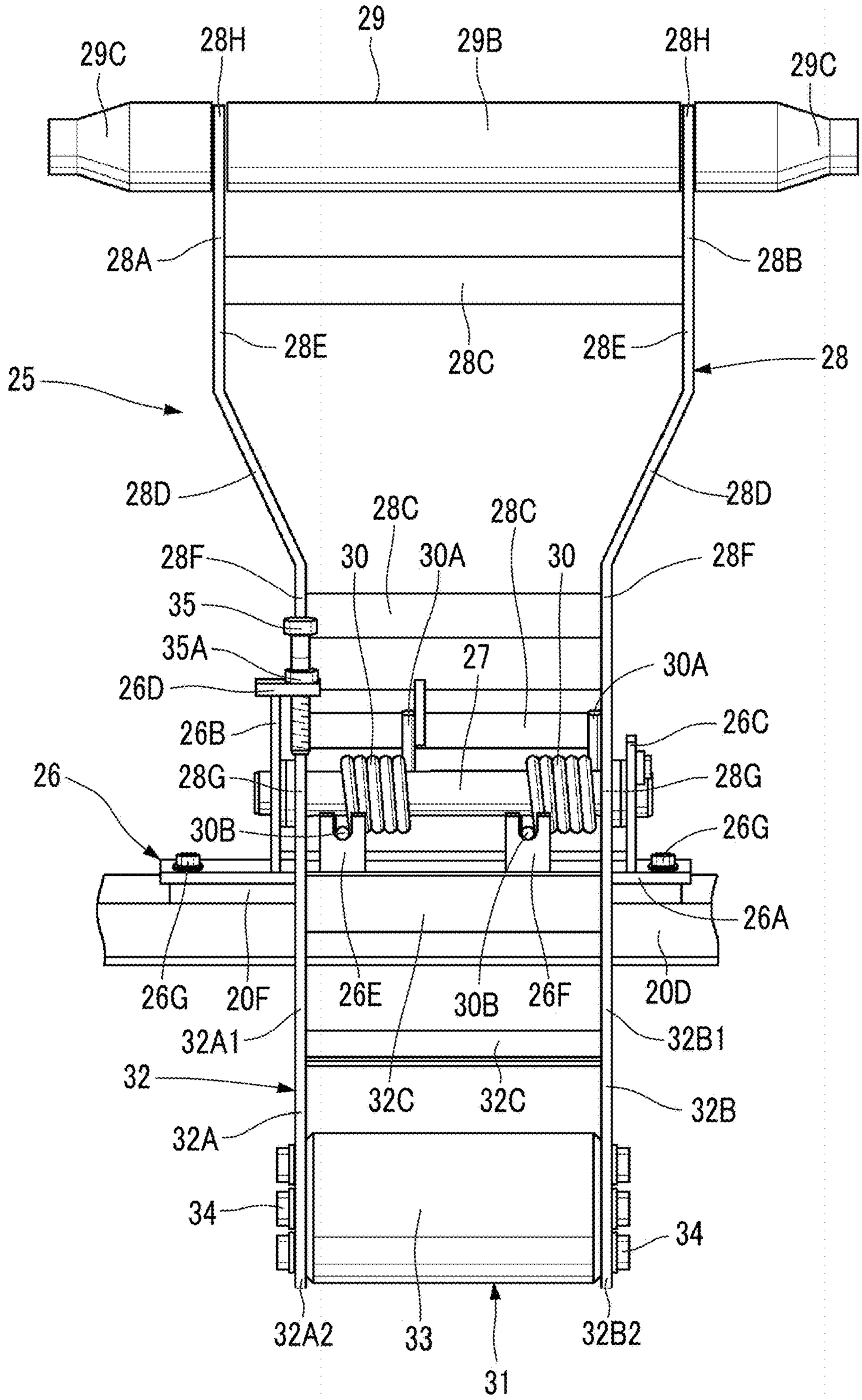
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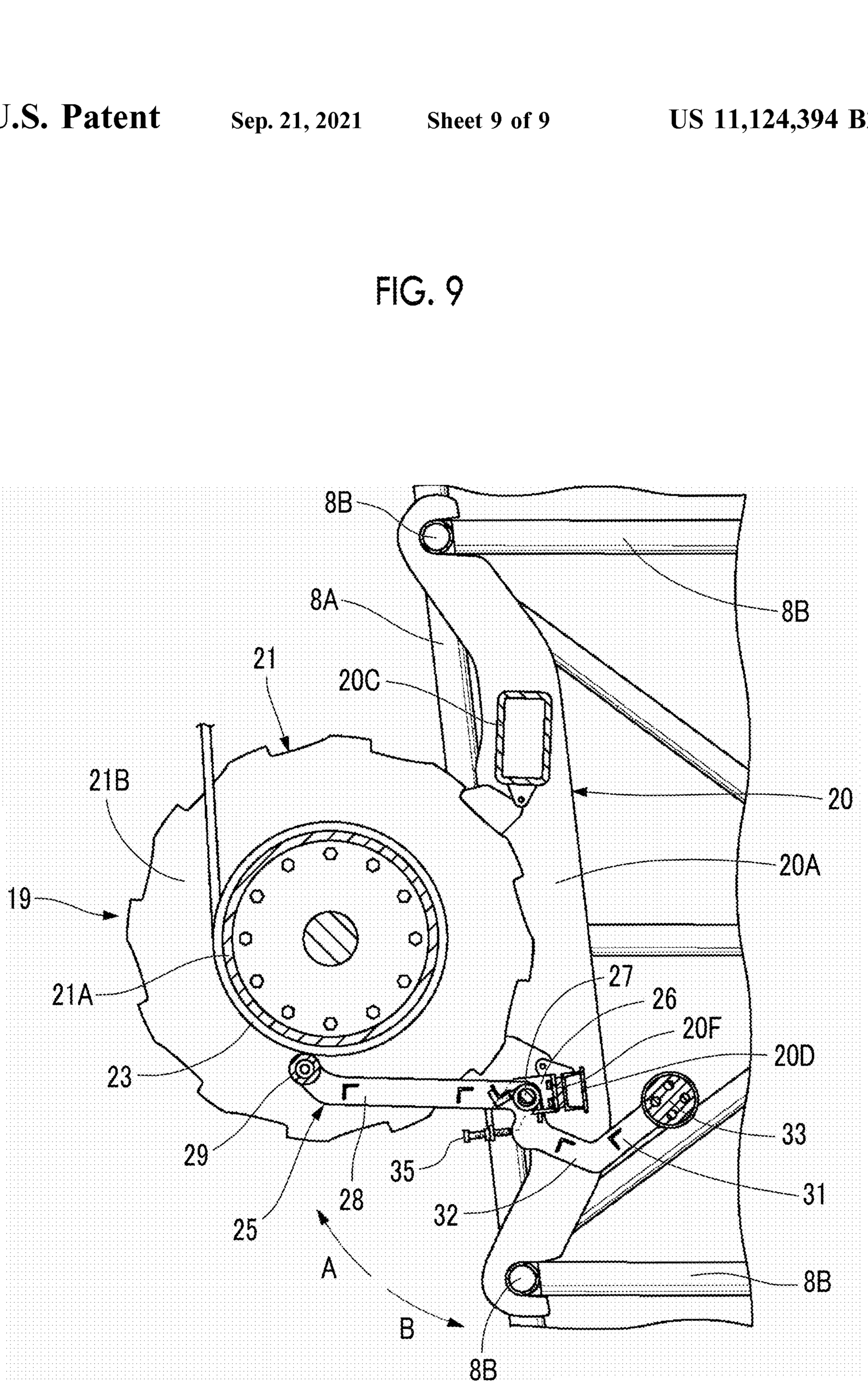
FIG. 9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CRANE

RELATED APPLICATIONS

The contents of Japanese Patent Application No. 2017-050768, and of International Patent Application No. PCT/JP2018/004497, on the basis of each of which priority benefits are claimed in an accompanying application data sheet, are in their entirety incorporated herein by reference.

BACKGROUND

Technical Field

Certain embodiment of the present invention relates to a crane which is suitably used to transport a material to a high place at a construction site, for example.

Description of Related Art

In general, a crane used to transport a material to a high place at a construction site or the like includes a boom derricking winch which performs a derricking operation on a boom, a main winding winch which raises or lowers a hook suspended from a distal end of the boom, an auxiliary winding winch which raises or lowers an auxiliary hook suspended from a distal end of a jib, or the like. In addition, the crane (tower crane) having the jib on the distal end of the boom includes a jib derricking winch which performs a derricking operation on the jib.

A hoisting winch mounted on the crane includes a cylindrical drum and a hydraulic motor which rotationally drives the drum, the drum is rotated normally or reversely by the hydraulic motor, and thus, a rope such as a wire rope is wound or unwound around the drum. For example, the main winding winch winds or unwind a main winding rope around a main winding drum to raise or lower a hook provided at a distal end of the main winding rope, and thus, a cargo handling work is performed using this hook.

Here, in general, the rope wound around the drum is wound in a multilayer shape in a state where the rope is closely arranged in an axial direction of the drum. Meanwhile, in a case where the rope is loosened for some reasons, the rope may be not be wound in a state where the rope is arranged. In this case, the rope is irregularly wound, and thus, there is a concern that durability of the rope may decrease.

Meanwhile, in the related art, a hoisting winch which includes a rope holding device in order to suppress irregular winding of the rope around the drum is known. The rope holding device includes a presser roller which is disposed between a pair of flanges provided on both ends of a drum in an axial direction and a spring which biases the presser roller toward the drum. Moreover, a rope wound around the drum is pressed against the drumby the presser roller biased by the spring, and thus, loosening of the rope is suppressed, and the rope can be wound around the drum in a state where the rope is arranged.

SUMMARY

According to an embodiment of the present invention, there is provided a crane including: a crane body; a boom whose proximal end is attached to the crane body so as to perform a derricking operation; a hoisting winch which includes a base which is fixed to the boom, a drum which is rotatably provided in the base and around which a rope is wound, and a pair of flanges which is provided on both axial sides of the drum; and a rope holding device which presses the rope wound around the drum of the hoisting winch against the drum, in which the rope holding device includes an oscillating arm whose proximal end is attached to the base using a support shaft and distal end oscillates in a direction close to or away from the drum with the support shaft as a fulcrum, and a rope presser which is attached to a distal end of the oscillating arm, extends in an axial direction of the drum between the pair of flanges, and abuts against the rope wound around the drum.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view showing a crane according to an embodiment of the present invention.

FIG. **2** is a front view showing state where a boom of the crane extends to be substantially horizontal to the ground.

FIG. **3** is a front view showing state where the boom of the crane stands up to be substantially perpendicular to the ground.

FIG. **4** is a plan view when a main winding winch, an auxiliary winding winch, or the like mounted on the boom is viewed in an arrow IV-IV direction in FIG. **2**.

FIG. **5** is a cross sectional view when the main winding winch, a rope holding device, or the like is viewed in an arrow V-V direction in FIG. **4**.

FIG. **6** is a main portion enlarged cross sectional view showing the rope holding device in FIG. **5**.

FIG. **7** is a main portion enlarged view when the main winding winch and the rope holding device are viewed in an arrow VII-VII direction in FIG. **5**.

FIG. **8** is a main portion enlarged view showing the rope holding device in FIG. **7**.

FIG. **9** is a cross sectional view at the same position as in FIG. **5** showing the main winding winch, the rope holding device, or the like in a state where the boom stands up.

DETAILED DESCRIPTION

A crane is known, in which a hoisting winch mounted on the crane is not only mounted on a crane body (vehicle body), but also a hoisting winch is mounted on a boom which can perform a derricking operation with respect to the crane body.

In the crane in which the hoisting winch is mounted on the boom, when the boom has a posture which is inclined with a relatively small angle with respect to the ground, a rope holding device can press a rope against a drum by a presser roller biased by the spring, and thus, the rope can be wound around the drum in a state where the rope is arranged.

However, when the boom has a posture (tower posture) which stands up to be substantially perpendicular to the ground, a moment in a direction away from the drum is generated in the presser roller. This moment acts in a direction opposite to a direction of a biasing force acting on the presser roller by the spring, and thus, a pressing force of the presser roller acting on the rope wound around the drum decreases. As a result, there is a problem that the rope cannot be wound around the drum in a state where the rope is arranged.

It is desirable to provide a crane capable of winding the rope around the drum of the hoisting winch mounted on the boom in a state where the rope is arranged, regardless of a posture of the boom.

A feature of the present invention is that a weight member, which biases a distal end side of an oscillating arm in a

direction close to the drum by the gravity with a support shaft as a fulcrum, is provided at a proximal end of the oscillating arm.

According to the present invention, a moment with the support shaft as a fulcrum is generated in the oscillating arm by the weight member provided at the proximal end of the oscillating arm, and the distal end side of the oscillating arm can be biased in the direction close to the drum. Accordingly, the rope can be pressed against the drum by a rope presser attached to the distal end of the oscillating arm regardless of a posture of the boom performing a derricking operation with respect to the crane body, and the rope can be wound in a state where the rope is arranged on the drum.

Hereinafter, an embodiment of a crane according to the present invention will be described in detail with reference to FIGS. **1** to **9**.

In FIG. **1**, a crane **1** according to an embodiment is configured to include a self-propelled crawler type lower traveling body **2**, an upper turning body **3** which is turnably mounted on the lower traveling body **2**, and a boom **7** described later which is attached to a front side of the upper turning body so as to perform a derricking operation, and performs a cargo handling work using a hook **24** described later suspended from a distal end of the boom **7**.

Here, the upper turning body **3** constitutes a crane body of the crane **1** and has a turning frame **4** which extends in forward and rearward directions. A boom attachment portion **4**A is provided on a front side of the turning frame **4** and a proximal end of the boom **7** is attached to the boom attachment portion **4**A so as to perform a derricking operation.

Moreover, a mast attachment portion **4**B is provided behind the boom attachment portion **4**A of the turning frame **4**, and a proximal end of a mast **14** described later is rotatably attached to the mast attachment portion **4**B. Furthermore, a backstop attachment portion **4**C is provided behind the mast attachment portion **4**B of the turning frame **4**, and a proximal end of a backstop **13** described later is rotatably attached to the backstop attachment portion **4**C.

A counterweight **5** is disposed behind the turning frame **4** to weight-balance the boom **7** and a hanging load. Further, a lower spreader **16** and a boom derricking winch **17** described later are disposed behind the turning frame **4** so as to be separated from each other in the front and rear. Meanwhile, a cab **6** is disposed on a right front side (a right side of the boom **7**) of the turning frame **4** and a driver's seat and various operation devices (all not shown) are disposed in a driver's cabin defined by the cab **6**.

The boom **7** is attached to the turning frame **4** of the upper turning body **3** so as to perform a derricking operation. Here, the boom **7** includes a lower boom **8** and an upper boom **9** connected to a distal end of the lower boom **8**.

A proximal end bracket **8**C is provided at a proximal end of the lower boom **8**, and the proximal end bracket **8**C is attached to the boom attachment portion **4**A of the turning frame **4** via a pin **10** so as to perform a derricking operation. A backstop support bracket **8**D is provided on a distal end side of the lower boom **8**, and a distal end of the backstop **13** is attached to the backstop support bracket **8**D. Moreover, a main winding winch **19** and an auxiliary winding winch **36** described later are mounted on the lower boom **8** so as to be arranged in a length direction.

Meanwhile, sheave brackets **9**C and **9**D are provided at a distal end of the upper boom **9**. A guide sheave **11** is rotatably attached to the sheave bracket **9**C, and a point sheave **12** is rotatably attached to the sheave bracket **9**D. A main winding rope **23** described later is wound around the guide sheave **11** and the point sheave **12**.

The backstop **13** is provided between the turning frame **4** and the boom **7**. That is, a proximal end of the backstop **13** is attached to the backstop attachment portion **4**C of the turning frame **4**, and a distal end of the backstop **13** is attached to the backstop support bracket **8**D of the lower boom **8**. The backstop **13** is extended or shrunk in accordance with a derricking angle of the boom **7** and supports the upright standing boom **7** from behind when the boom **7** stands up to be substantially perpendicular to the ground.

The mast **14** is provided on the turning frame **4** so as to be rotatable in the forward and backward directions. That is, a proximal end of the mast **14** is rotatably pin-connected to the mast attachment portion **4**B of the turning frame **4**, and a distal end **14**A of the mast **14** becomes a free end which can turn in the forward and backward directions with respect to the turning frame **4**. The distal end **14**A of the mast **14** and a pendant attachment portion **9**E of the upper boom **9** are connected to each other via a pendant rope **18**A. Further, an upper spreader **15** having a plurality of sheaves is provided on the distal end **14**A of the mast **14**.

Meanwhile, a lower spreader **16** and a boom derricking winch **17** are provided behind the turning frame **4**. The lower spreader **16** has a plurality of sheaves corresponding to the respective sheaves of the upper spreader **15**.

The boom derricking winch **17** winds and unwinds a boom derricking rope **18** to perform a derricking operation on the boom **7** via the mast **14**. One end of the boom derricking rope **18** is wound around a drum of the boom derricking winch **17**, and the other end thereof is wound around each sheave of the upper spreader **15** and each sheave of the lower spreader **16**.

Therefore, when the boom derricking rope **18** is wound by the boom derricking winch **17**, the upper spreader **15** moves close to the lower spreader **16** and the distal end **14**A of the mast **14** rotates rearward (toward a side of the counterweight **5**). Meanwhile, when the boom derricking rope **18** is unwound from the boom derricking winch **17**, the upper spreader **15** is separated from the lower spreader **16**, and the distal end **14**A of the mast **14** rotates forward (toward a side of the cab **6**). In this way, the boom derricking rope **18** is wound or unwound by the boom derricking winch **17**, and thus, the boom **7** can perform a derricking operation between a posture at which the boom **7** is inclined about the pin **10** with a relatively small angle to the ground as shown in FIG. **2** and a posture (tower posture) at which the boom **7** stands up to be substantially perpendicular to the ground as shown in FIG. **3**.

Next, the main winding winch **19** and the rope holding device **25** used in the present embodiment will be described.

The main winding winch **19** is mounted on the lower boom **8** together with the auxiliary winding winch **36** described later. The main winding winch **19** constitutes a hoisting winch which winds and unwinds a main winding rope **23** described later. As shown in FIGS. **2** to **4**, the main winding winch **19** is configured to include a base **20** described later, a main winding drum **21**, and a hydraulic motor **22**.

The base **20** is fixed to a beam **8**B which connects the plurality of main members **8**A constituting the lower boom **8** to each other by means of welding or the like. As shown in FIG. **4** and FIG. **5**, the base **20** is formed in a substantially rectangular frame shape by a left base plate **20**A and a right base plate **20**B which are constituted by plates extending in a length direction of the lower boom **8** while facing each other with a gap in right and left directions, a wide connec-

tion member **20**C which is constituted by a wide angular tubular body and connects the left and right base plates **20**A and **20**B to each other, and a narrow connection member **20**D which is formed using a channel steel or the like having a width narrower than that of the wide connection member **20**C and connects the left and right base plates **20**A and **20**B to each other. A central portion of each of the left and right base plates **20**A and **20**B in the length direction is a drum support portion **20**E which protrudes in a mountain shape toward an outside of the lower boom **8** and the main winding drum **21** is supported by the drum support portion **20**E. Moreover, a thick plate-shaped screw seat **20**F is provided at a central portion of the narrow connection member **21**D in the right and left directions, and the rope holding device **25** described later is attached to the screw seat **20**F (refer to FIG. **6**).

The main winding drum **21** is rotatably provided on the left and right base plates **20**A and **20**B constituting the base **20**. As shown in FIG. **7**, the main winding drum **21** is configured to have a cylindrical winding drum **21**A whose axial center extends in the right and left directions between the left and right base plates **20**A and **20**B, and left and right flanges **21**B, and left and right flanges **21**B which are formed in a disk shape having a diameter larger than that of the winding drum **21**A and are provided on axial both sides of the winding drum **21**A. The main winding drum **21** is rotatably supported by the drum support portions **20**E of the left and right base plates **20**A and **20**B constituting the base **20**, via a bearing or the like, and winds and unwinds the main winding rope **23**.

The hydraulic motor **22** is provided on a surface of the left base plate **20**A constituting the base **20** opposite to the main winding drum **21**. For example, the hydraulic motor **22** is rotated by pressure oil supplied from a hydraulic pump (not shown) mounted on the upper turning body **3**. A rotation of the hydraulic motor **22** is decelerated by a reduction mechanism provided in the main winding drum **21**, and the main winding drum **21** can rotate with a large torque. Moreover, for example, the main winding rope **23** can be wound around an outer peripheral surface of the winding drum **21**A by rotating the main winding drum **21** in a normal direction by the hydraulic motor **22**, and the main winding rope **23** can be unwound from the winding drum **21**A by rotating the main winding drum **21** in a reverse direction.

The main winding rope **23** is wound around the main winding drum **21** of the main winding winch **19**. One end side of the main winding rope **23** is wound around the winding drum **21**A of the main winding drum **21**, and the other end side of the main winding rope **23** is wound around the guide sheave **11** and the point sheave **12** provided on the distal end side of the upper boom **9**, and thereafter, is attached to the hoisting hook **24**. Therefore, the hook **24** can be raised and lowered by winding and unwinding the main winding rope **23** by the main winding winch **19**. In addition, when the main winding rope **23** is wound around the main winding drum **21**, the main winding rope **23** is wound in a multilayer shape in a state where the main winding rope **23** is closely arranged in an axial direction of the main winding drum **21** by the rope holding device **25** described later.

The rope holding device **25** is attached to the narrow connection member **20**D which constitutes the base **20** of the main winding winch **19**. The rope holding device **25** presses the main winding rope **23** wound around the main winding drum **21** of the main winding winch **19** against the winding drum **21**A, and thus, prevents irregular winding of the main winding rope **23** with respect to the main winding drum **21**. As shown in FIGS. **5** to **9**, the rope holding device **25** is configured to include an attachment plate **26**, a support shaft **27**, an oscillating arm **28**, a presser roller **29**, and a weight member **31** described later.

The attachment plate **26** is attached to the screw seat **20**F which is disposed at the center portion of the narrow connection member **20**D. The attachment plate **26** includes a lower plate **26**A which is constituted by a rectangular plate extending in the right and left directions, and a left vertical plate **26**B and a right vertical plate **26**C which are erected on the lower plate **26**A and face each other with a gap in the right and left directions. As shown in FIGS. **5** and **6**, a distal end of the left vertical plate **26**B protrudes in a direction away from the main winding drum **21**, and a stopper attachment plate **26**D for attaching an arm stopper **35** described later is provided on a protruding end thereof. Further, spring receiving plates **26**E and **26**F for latching the other end **30**B of a torsion spring **30** described later are provided between the left vertical plate **26**B and the right vertical plate **26**C. In addition, the lower plate **26**A of the attachment plate **26** is attached to the screw seat **21**F of the narrow connection member **21**D using a bolt **26**G.

The support shaft **27** is provided between the left vertical plate **26**B and the right vertical plate **26**C of the attachment plate **26** so as to extend in the right and left directions. For example, the support shaft **27** is constituted by a single shaft formed of a central round bar, is inserted into shaft insertion holes (not shown) formed in the left vertical plate **26**B and the right vertical plate **26**C, is supported by the left and right vertical plates **26**B and **26**C in a state in which the support shaft **27** is clamped and axially retained. The support shaft **27** supports the oscillating arm **28** such that the oscillating arm **28** can be oscillated and supports the torsion spring **30**.

The oscillating arm **28** is attached to the base **20** of the main winding winch **19** using the support shaft **27** and can oscillate with the support shaft **27** as a fulcrum. The oscillating arm **28** is configured to include a left arm plate **28**A and a right arm plate **28**B which are constituted by plates extending in a direction orthogonal to the support shaft **27** and face each other with a gap in the right and left directions, and a plurality of (for example, three) connection members **28**C which are constituted by plates having an L-shaped cross section and connect the left and right arm plates **28**A and **28**B to each other. A bending portion **28**D is provided in an intermediate portion of each of the left and right arm plates **28**A and **28**B in the length direction, and the oscillating arm **28** has a wide portion **28**E having a wide gap between the left and right arm plates **28**A and **28**B and a narrow portion **28**F having a narrow gap between the left and right arm plates **28**A and **28**B with the bending portion **28**D as a boundary portion.

Here, an extension arm portion **32** which constitutes the weight member **31** described later is integrally formed in the narrow portion **28**F of the oscillating arm **28**. That is, in the left and right arm plates **28**A and **28**B, a range connecting the support shaft **27** and the presser roller **29** to each other constitutes the oscillating arm **28**. Meanwhile, a range which connects the support shaft **27** and a weight body **33** described later to each other constitutes the extension arm portion **32** of the weight member **31**.

The support shaft **27** is inserted through proximal ends **28**G of the narrow portion **28**F of the oscillating arm **28**, and the oscillating arm **28** is supported by the support shaft **27** so as to be oscillated. Therefore, each of distal ends **28**H of the wide portion **28**E of the oscillating arm **28** is a free end which oscillates in a direction close to or away from the main winding drum **21** with the support shaft **27** as a

fulcrum. In addition, the presser roller **29** is attached to the distal ends **28**H of the wide portion **28**E of the oscillating arm **28**.

The presser roller **29** is attached to the distal ends **28**H of the wide portion **28**E of the oscillating arm **28**. The presser roller **29** constitutes a rope presser which abuts against the main winding rope **23** wound around the main winding drum **21**. Here, the presser roller **29** is configured to include a roller shaft **29**A (refer to FIG. **6**) which is provided so as to penetrate the portion between the left and right arm plates **28**A and **28**B in the right and left directions, and a cylindrical roller body **29**B which is rotatably attached to the roller shaft **29**A via a bearing or the like (not shown).

The roller body **29**B of the presser roller **29** is disposed between the left and right flanges **21**B of the main winding drum **21**, and extends in an axial direction of the main winding drum **21** over substantially the entire length of the winding drum **21**A. The roller body **29**B abuts against the main winding rope **23** wound around the winding drum **21**A of the main winding drum **21** so that the main winding rope **23** is wound in a state where the main winding rope **23** is closely arranged in the axial direction of the winding drum **21**A. In addition, both left and right ends **29**C of the roller body **29**B have a substantially truncated conical shape in order to prevent the main winding rope **23** wound around the main winding drum **21** from being irregularly wound in the vicinity of each flange **21**B.

The left and right torsion springs **30** are provided one each (two in total) in the vicinity of the left and right arm plates **28**A and **28**B in a state where the torsion springs **30** are supported by the support shaft **27**. Each of the left and right torsion springs **30** is constituted by a torsion coil spring, and a coil portion of each spring is inserted into an outer peripheral side of the support shaft **27**. One end **30**A of the torsion spring **30** on the left side (left arm plate **28**A side) is latched to the connection member **28**C of the oscillating arm **28**, and the other end **30**B thereof is latched to the spring receiving plate **26**E of the attachment plate **26**. Moreover, one end **30**A of the torsion spring **30** on the right side (right arm plate **28**B side) is latched to the connection member **28**C of the oscillating arm **28** and the other end **30**B thereof is latched to the spring receiving plate **26**F of the attachment plate **26**.

The left and right torsion springs **30** bias the oscillating arm **28** of the rope holding device **25** in a direction close to the main winding drum **21** with the support shaft **27** as a fulcrum, and apply an elastic pressing force with respect to the main winding rope **23** to the presser roller **29**. Accordingly, the presser roller **29** presses the main winding rope **23** toward the winding drum **21**A of the main winding drum **21**, and prevents the irregular winding of the main winding rope **23** with respect to the main winding drum **21**. That is, when the main winding rope **23** is wound around the winding drum **21**A of the main winding drum **21**, the presser roller **29** of the rope holding device **25** rotates about the roller shaft **29**A while pressing the main winding rope **23** to the main winding drum **21** (winding drum **21**A) by spring forces of the left and right torsion springs **30**. Therefore, the main winding rope **23** is wound in a multilayer shape in a state where the main winding rope **23** is closely arranged on the winding drum **21**A of the main winding drum **21**.

Next, the weight member **31** used in the present embodiment will be described.

The weight member **31** is integrally provided with the proximal end **28**G of the oscillating arm **28** which constitutes the rope holding device **25**. The weight member **31** biases the distal end **28**H of the oscillating arm **28** in the direction close to the main winding drum **21** by the gravity, with the support shaft **27** as a fulcrum. Here, the weight member **31** is configured to include the extension arm portion **32** and the weight body **33** described later.

The extension arm portion **32** is integrally formed with the proximal end **28**G of the oscillating arm **28** and can oscillate together with the oscillating arm **28** using the support shaft **27** as a fulcrum. The extension arm portion **32** is configured to include a left extension arm plate **32**A which is connected to the left arm plate **28**A of the oscillating arm **28** and extends in a direction away from the presser roller **29** across the support shaft **27**, a right extension arm plate **32**B which is connected to the right arm plate **28**B of the oscillating arm **28** and extends in the direction away from the presser roller **29** across the support shaft **27**, and a plurality of (for example, two) connection members **32**C which are constituted by plates having an L-shaped cross section and connect the left and right extension arm plates **32**A and **32**B to each other.

In an intermediate portion of the left extension arm plate **32**A in a length direction thereof, a mountain-shaped bending portion **32**A**1** is provided to avoid an interference with the narrow connection member **20**D constituting the base **20**. Further, a disk-shaped weight attachment portion **32**A**2** is provided at a distal end of the left extension arm plate **32**A, and a plurality of (for example, four) bolt insertion holes (not shown) penetrating the weight attachment portion **32**A**2** in a thickness direction are provided in the weight attachment portion **32**A**2**. Similarly, a mountain-shaped bending portion **32**B**1** is provided in an intermediate portion of the right extension arm plate **32**B in the length direction thereof, and a disk-shaped weight attachment portion **32**B**2** having a plurality of bolt insertion holes (not shown) penetrating the weight attachment portion **32**B**2** is provided at a distal end of the right extension arm plate **32**B.

The weight body **33** constitutes a weight portion provided at the distal end of the extension arm portion **32**. The weight body **33** is formed of a columnar weight having an axial dimension corresponding to a gap between the left and right extension arm plates **32**A and **32**B. A plurality of (for example, four) female screw holes (not shown) are formed on each of both axial end surfaces of the weight body **33**, and bolts **34** inserted into the weight attachment portions **32**A**2** and **32**B**2** of left and right extension arm plates **32**A and **32**B are screwed into respective female screw holes of the weight body **33**. Accordingly, the weight body **33** is detachably attached to the weight attachment portions **32**A**2** and **32**B**2** of the left and right extension arm plates **32**A and **32**B.

In this way, in the rope holding device **25** according to the present embodiment, the extension arm portion **32** is integrally formed with the proximal end **28**G of the oscillating arm **28**, and the weight body **33** is attached to the distal end of the extension arm portion **32** extending in the direction away from the presser roller **29** across the support shaft **27**. Thus, for example, as shown in FIG. **3** and FIG. **9**, in a state where the boom **7** stands up, a moment in a direction (arrow A direction in FIG. **9**) close to the main winding drum **21** with the support shaft **27** as a fulcrum is generated in the distal end **28**H of the oscillating arm **28** having the presser roller **29**, by the gravity acting on the weight member **31** including the extension arm portion **32** and the weight body **33**.

As a result, even in the state where the boom **7** stands up, it is possible to press the presser roller **29** against the main winding rope **23** wound around the main winding drum **21** with the support shaft **27** as a fulcrum, by the gravity acting on the weight member **31** or the like, and it is possible to

suppress the irregular winding of the main winding rope **23**. In this case, a magnitude of the moment generated in the oscillating arm **28** can be set according to a length of the extension arm portion **32** and weight of the weight body **33**, and thus, it is possible to appropriately adjust the pressing force of the presser roller **29** with respect to the main winding rope **23**.

Here, the arm stopper **35** is attached to the stopper attachment plate **26**D which constitutes the attachment plate **26** of the rope holding device **25**. The arm stopper **35** is constituted by a bolt which is screwed into a female screw hole (not shown) formed in the stopper attachment plate **26**D, and a distal end of the arm stopper **35** abuts against the left extension arm plate **32**A. The arm stopper **35** is fixed to the stopper attachment plate **26**D by a lock nut **35**A. Therefore, by adjusting a protrusion length of the arm stopper **35** protruding from the stopper attachment plate **26**D toward the left extension arm plate **32**A, it is possible appropriately set a gap between the presser roller **29** and the winding drum **21**A when the presser roller **29** provided at the distal end **28**H of the oscillating arm **28** moves closest to the winding drum **21**A of the main winding drum **21**.

The auxiliary winding winch **36** is located between the pin **10** and the main winding winch **19** and is mounted on the lower boom **8**. As shown in FIG. **4**, approximately similarly to the main winding winch **19**, the auxiliary winding winch **36** is configured to include a base **37** which is fixed to the plurality of beams **8**B constituting the lower boom **8** and extends in the forward and rearward directions, a cylindrical auxiliary winding drum **38** which is rotatably attached to the base **37** and extends in the right and left directions, and a hydraulic motor **39** which rotationally drives the auxiliary winding drum **38**. Disc-shaped flanges **38**A are provided on both axial sides of the auxiliary winding drum **38**, and an auxiliary winding rope **40** for suspending an auxiliary hook (not shown) is wound around an outer peripheral side of the auxiliary winding drum **38**.

Here, the base **37** is formed in a substantially rectangular frame shape by left and right base plates **37**A and **37**B and a wide connection member **37**C and a narrow connection member **37**D connecting the left and right base plates **37**A and **37**B to each other. A rope holding device **41** for suppressing irregular winding of the auxiliary winding rope **40** by pressing the auxiliary winding rope **40** against the auxiliary winding drum **38** is provided in the narrow connection member **37**D of the base **37**.

The crane **1** according to the present embodiment has the configuration as described above, and next, an operation of the crane **1** is described.

When the cargo handling work is performed using the crane **1**, for example, as shown in FIG. **1**, the boom derricking rope **18** is wound by the boom derricking winch **17**, and thus, the boom **7** is raised up about the pin **10** with respect to the turning frame **4**.

In this state, the main winding drum **21** is rotated by the hydraulic motor **22** of the main winding winch **19**. Accordingly, the main winding rope **23** can be wound around and unwound from the winding drum **21**A of the main winding drum **21**, and thus, the hook **24** can be raised or lowered, and a hanging load such as a material suspended from the hook **24** can be transported between the ground and a high location.

Here, when the main winding rope **23** is wound around the winding drum **21**A of the main winding drum **21**, for example, the main winding drum **21** is rotated in the normal direction by the hydraulic motor **22**. Accordingly, the main winding rope **23** can be wound around the outer peripheral surface of the winding drum **21**A. In this case, the distal end **28**H of the oscillating arm **28** of the rope holding device **25** is biased in the direction close to the main winding drum **21** with the support shaft **27** as a fulcrum, by the spring forces of the torsion springs **30**. Therefore, the presser roller **29** provided at the distal end **28**H of the oscillating arm **28** abuts against the main winding rope **23** wound around the winding drum **21**A of the main winding drum **21** and presses the main winding rope **23** against the outer peripheral surface of the winding drum **21**A with an appropriate force while being rotated about the roller shaft **29**A. As a result, the main winding rope **23** is not irregularly wound, and is wound in a multilayer shape in a state where the main winding rope **23** is closely arranged on the outer peripheral surface of the winding drum **21**A.

Meanwhile, for example, as shown in FIG. **3** and FIG. **9**, in a case where the boom **7** stands up so as to be substantially perpendicular to the ground, a moment in an arrow B direction in FIG. **9** (the direction in which the presser roller **29** moves away from the main winding drum **21**) with the support shaft **27** as a fulcrum is generated in the oscillating arm **28**, by the weight of the presser roller **29** or the like provided at the distal end **28**H of the oscillating arm **28** Meanwhile, in the present embodiment, the extension arm portion **32** is integrally formed with the proximal end **28**G of the oscillating arm **28**, and the weight body **33** is attached to the distal end of the extension arm portion **32** extending in the direction away from the presser roller **29** across the support shaft **27**.

Accordingly, in the state where the boom **7** stands up to be substantially perpendicular to the ground, the moment in a direction (arrow A direction in FIG. **9**) close to the main winding drum **21** with the support shaft **27** as a fulcrum is generated in the distal end **28**H of the oscillating arm **28** having the presser roller **29**, by the gravity acting on the weight member **31** including the extension arm portion **32** and the weight body **33**. Therefore, even in a case where the main winding rope **23** is wound around the main winding drum **21** in the state where the boom **7** stands up, it is possible to assist the torsion springs **30** by the gravity acting on the weight member **31** or the like, and it is possible to press the presser roller **29** against the main winding rope **23** wound around the main winding drum **21** with an appropriate force.

As a result, the main winding rope **23** can be pressed against the winding drum **21**A of the main winding drum **21** by the presser roller **29** attached to the distal end **28**H of the oscillating arm **28** regardless of the posture of the boom **7** performing the derricking operation with respect to the turning frame **4**, and thus, the rope **23** can be wound in a multilayer shape in the state where the main winding rope **23** is closely arranged on the outer peripheral surface of the winding drum **21**A.

Therefore, the crane **1** according to the present embodiment is configured to include the main winding winch **19** which includes the base **20** fixed to the lower boom **8** of the boom **7** and the main winding drum **21** around which the main winding rope **23** is wound, and the rope holding device **25** which presses the main winding rope **23** wound around the main winding drum **21** of the main winding winch **19** against the main winding drum **21**, in which the rope holding device **25** is configured to include the oscillating arm **28** whose proximal end **28**G is attached to the base **20** using the support shaft **27** and distal end **28**H oscillates in the direction close to or away from the main winding drum **21** with the support shaft **27** as a fulcrum, and the presser roller **29** which is attached to the distal end **28**H of the oscillating arm **28** and

abuts against the main winding rope **23** wound around the main winding drum **21**, and the weight member **31**, which biases the distal end **28**H of the oscillating arm **28** in the direction close to the main winding drum **21** by the gravity with the support shaft **27** as a fulcrum, is provided in the proximal end **28**G of the oscillating arm **28**.

Accordingly, the moment with the support shaft **27** as a fulcrum is generated in the oscillating arm **28** by the gravity acting on the weight member **31**, and the distal end **28**H of the oscillating arm **28** can be biased in the direction close to the main winding drum **21**. Therefore, the main winding rope **23** can be pressed against the winding drum **21**A of the main winding drum **21** by the presser roller **29** attached to the distal end **28**H of the oscillating arm **28** regardless of the posture of the boom **7** performing the derricking operation with respect to the turning frame **4**, and thus, the main winding rope **23** can be wound in the state where the main winding rope **23** is arranged on the main winding drum **21**.

In this case, the weight member **31** is integrally provided with the oscillating arm **28** and rotatably supported by the support shaft **27**. Accordingly, the weight member **31** oscillates integrally with the oscillating arm **28** with the support shaft **27** as a fulcrum, and thus, the presser roller **29** attached to the distal end **28**H of the oscillating arm **28** abuts against the main winding rope **23** using the gravity acting on the weight member **31**, and the main winding rope **23** can be pressed against the main winding drum **21** with an appropriate force.

Moreover, the weight member **31** is configured by the extension arm portion **32** which extends in the direction away from the presser roller **29** across the support shaft **27** and the weight body **33** which is provided on the distal end of the extension arm portion **32**. Therefore, the magnitude of the moment generated in the oscillating arm **28** by the gravity acting on the weight body **33** can be set according to the length of the extension arm portion **32**, and the pressing force of the presser roller **29** against the main winding rope **23** can be appropriately adjusted.

In addition, in the embodiment, the case is exemplified, in which the weight member **31** is provided in the rope holding device **25** which presses the main winding rope **23** against the main winding drum **21**. However, the present invention is not limited to this. For example, the weight member may be provided in the rope holding device **41** which presses the auxiliary winding rope **40** against the auxiliary winding drum **38**.

Moreover, in the embodiment, the case is exemplified, in which the left and right extension arm plates **32**A and **32**B constituting the extension arm portion **32** of the weight member **31** are respectively formed integrally with the proximal ends **28**G of the left and right arm plates **28**A and **28**B constituting the oscillating arm **28** of the rope holding device **25**. However, the present invention is not limited to this. For example, the left and right extension arm plates constituting the extension arm portion may be formed of members separated from the left and right arm plates constituting the oscillating arm, using bolts or the like, and may be detachably attached to the proximal ends of the left and right arm plates using a bolt or the like.

Moreover, in the embodiment, a case is exemplified, in which each of the torsion springs **30** is used as a spring for biasing the oscillating arm **28** of the rope holding device **25** in the direction close to the main winding drum **21**. However, the present invention is not limited to this, and for example, a compression spring or a tension spring may be used. Further, in the embodiment, a case in which one torsion spring **30** is disposed in each of the right and left sides of the support shaft **27** is exemplified. However, the present invention is not limited to this. For example, only one spring may be disposed on the right side or the left side of the support shaft **27**, one spring may be provided in a center and the left side of the support shaft **27**, one spring may be provided in the center and the right side of the support shaft **27**, and three or more springs may be disposed.

Moreover, in the present embodiment, the case in which the weight body **33** of the weight member **31** is formed in a columnar shape is exemplified. However, the present invention is not limited to this, and for example, the weight body **33** may be formed in a prismatic shape such as a square pole. Moreover, in the embodiment, the case in which the weight body **33** of the weight member **31** is detachably attached to the extension arm plates **32**A and **32**B using the bolt **34** is exemplified. However, the present invention is not limited to this, and for example, the weight body **33** may be fixed to the extension arm plates **32**A and **32**B by welding.

In addition, in the present embodiment, the crane **1** is exemplified, in which the hoisting winch such as the main winding winch **19** is mounted on the boom **7** (lower boom **8**) and the main winding rope **23** to which the hook **24** is attached is suspended from the distal end of the boom **7** (upper boom **9**). However, the present invention is not limited to this, and for example, the present invention can be applied to other cranes such as a tower crane in which a jib is attached to a distal end of a boom so as to perform a derricking operation and a hoisting winch is mounted on the boom.

It should be understood that the invention is not limited to the above-described embodiment, but may be modified into various forms on the basis of the spirit of the invention. Additionally, the modifications are included in the scope of the invention.

What is claimed is:

1. A crane comprising:

a crane body;

a boom whose proximal end is attached to the crane body so as to perform a derricking operation;

a hoisting winch which comprises:

a base which is fixed to the boom,

a drum which is rotatably provided in the base and around which a rope is wound, and

a pair of flanges which is provided on both axial sides of the drum; and

a rope holding device which presses the rope wound around the drum of the hoisting winch against the drum,

wherein the rope holding device comprises:

an oscillating arm whose proximal end is attached to the base using a support shaft and distal end oscillates in a direction toward or away from the drum with the support shaft as a fulcrum, and

a rope presser which is attached to a distal end of the oscillating arm, extends in an axial direction of the drum between the pair of flanges, and abuts against the rope wound around the drum, and

wherein a weight member is provided at the proximal end of the oscillating arm so that gravity applied to the weight member biases the distal end of the oscillating arm in a direction toward the drum with the support shaft as a fulcrum.

2. The crane according to claim **1**,

wherein the weight member is integrally provided with the oscillating arm and is rotatably supported by the support shaft.

3. The crane according to claim 1,
wherein the weight member includes an extension arm portion which extends in a direction away from the rope presser across the support shaft and a weight portion which is provided on a distal end of the extension arm portion.
4. The crane according to claim 1, further comprising:
a bias unit which presses the oscillating arm in the direction toward the drum regardless of a posture of the boom.
5. The crane according to claim 4,
wherein the gravity applied to the weight member biases the distal end side of the oscillating arm in the direction toward the drum with the support shaft as a fulcrum as the boom stands up.
6. The crane according to claim 1, further comprising:
a stopper which regulates a rotation of the oscillating arm in the direction toward the drum.
7. The crane according to claim 6,
wherein the stopper is configured to adjust a gap between a presser roller and a winding drum in a case where the stopper regulates the rotation of the oscillating arm in the direction toward the drum.
8. The crane according to claim 7,
wherein the stopper includes a protrusion portion which protrudes toward the oscillating arm, and adjusts the gap by adjusting a protruding length of the protrusion portion.
9. The crane according to claim 8,
wherein the protrusion portion is a bolt, and the gap is adjusted by screwing the bolt.
10. The crane according to claim 8,
wherein the protrusion portion is located on an upper side of the boom with respect to the weight member.
11. The crane according to claim 6,
wherein the oscillating arm includes a pair of left and right oscillating arms.
12. The crane according to claim 11,
wherein the stopper is arranged in one of the pair of the oscillating arms.
13. The crane according to claim 1,
wherein the weight member includes an extension arm portion which extends in a direction away from the rope presser across the support shaft and a weight portion which is provided on a side of the extension arm portion opposite to the support shaft.
14. The crane according to claim 13,
wherein the weight portion is arranged at a position opposite to the oscillating arm with the support shaft interposed therebetween and overlapping the support shaft when viewed from the oscillating arm.
15. The crane according to claim 14,
wherein the extension arm portion includes a bending portion which extends in a direction away from the base, the bending portion being arranged at a position opposite to the oscillating arm with the support shaft interposed therebetween and not overlapping the support shaft when viewed from the oscillating arm.
16. The crane according to claim 15,
wherein the base includes a pair of a left base plate and a right base plate which extend in a length direction of the boom and a connection member which connects the left and right base plates to each other.
17. The crane according to claim 16,
wherein the extension arm portion includes a bending portion which extends in a direction away from the connection member, the bending portion being arranged at a position opposite to the oscillating arm with the support shaft interposed therebetween and not overlapping the support shaft when viewed from the oscillating arm.
18. The crane according to claim 13,
wherein the extension arm portion includes a pair of a left extension arm plate and a right extension arm plate and a connection member which connects the left and right extension arm plates to each other.
19. The crane according to claim 1,
wherein the weight member includes an extension arm portion which extends in a direction away from the rope presser across the support shaft and a weight portion which is provided on a side of the extension arm portion opposite to the support shaft.
20. The crane according to claim 19,
wherein the weight portion is detachably fixed to the extension arm portion by a bolt.

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